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DESIGN AND OPERATING PARAMETERS FOR EMISSION CONTROL STUDIES: ASARCO, HAYDEN, COPPER SMELTER

I. J. Weisenberg, et al

Pacific Environmental Services,
Incorporated

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DESIGN AND OPERATING PARAMETERS FOR EMISSION CONTROL STUDIES: ASARCO, Hayden, Copper Smelter

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16. ABSTRACT The report gives background design data for a specific copper smelter. The data is sufficiently detailed to allow air pollution control system engineering studies to be conducted. These studies will be concerned primarily with lean SO2 streams that currently are not being captured. Physical layout of the smelter and the surrounding area is presented, along with existing control equipment. Ductwork that would be considered for future system tie-in is defined. Emissions from operating equipment, gas flow rates, temperatures, sulfur balance, and a process flow sheet are included. Utilities, stack dimensions, footing requirements, and solid waste handling are defined. Available area for new control equipment, gas characteristic variation, and potential new control equipment installation problems are discussed.

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Design	Operating Data	
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by

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THE FIGURES IN THIS DOCUMENT ARE NONREPRODUCIBLE

THEREFORE ARE EXCLUDED FROM THIS REPORT.

A. INTRODUCTION AND SUMMARY

The purpose of this report is to present background design data on the ASARCO Incorporated, Hayden Plant at Hayden, Arizona in sufficient detail to allow air pollution control system engineering studies to be conducted. These studies will be primarily concerned with lean SO_2 streams that are currently not being captured.

Physical layout of the smelter and surrounding area along with existing smelter and control equipment is presented. Ductwork that would be considered for future system tie-in is defined. Emissions from operating equipment, gas flow rates, temperatures, sulfur balance and process flow sheet are included. Utilities, stack dimensions, footing requirements and solid waste handling are defined. Available area for new control equipment, gas characteristic variation and potential new control equipment installation problems are discussed.

The major uncontrolled sources of SO_2 and particulates at this smelter are the reverberatory furnace and the roasters. Currently the total SO_2 emissions, including the portion of the converter emissions not captured in the acid plant, are approximately 250,000 tons per year. When ASARCO completes the rework of the acid plant enabling treatment of all converter emissions, the SO_2 emissions to the atmosphere will be approximately 173,000 tons per year. The total particulate emission rate is approximately 450 tons per year.

B. PLANT LOCATION, ACCESS AND OVERALL GENERAL ARRANGEMENT

The ASARCO smelter is located adjacent to the town of Hayden, Arizona. A section of the USGS map, showing land contours of the immediate area, is presented in Figure 1. Design altitude for the plant is about 2,120 ft. with latitude $33^{\circ}9'$ and longitude $110^{\circ}46'$.

The plant consists of an unloading operation, twelve roasters, two reverberatory furnaces, five converters, and two anode furnaces with two

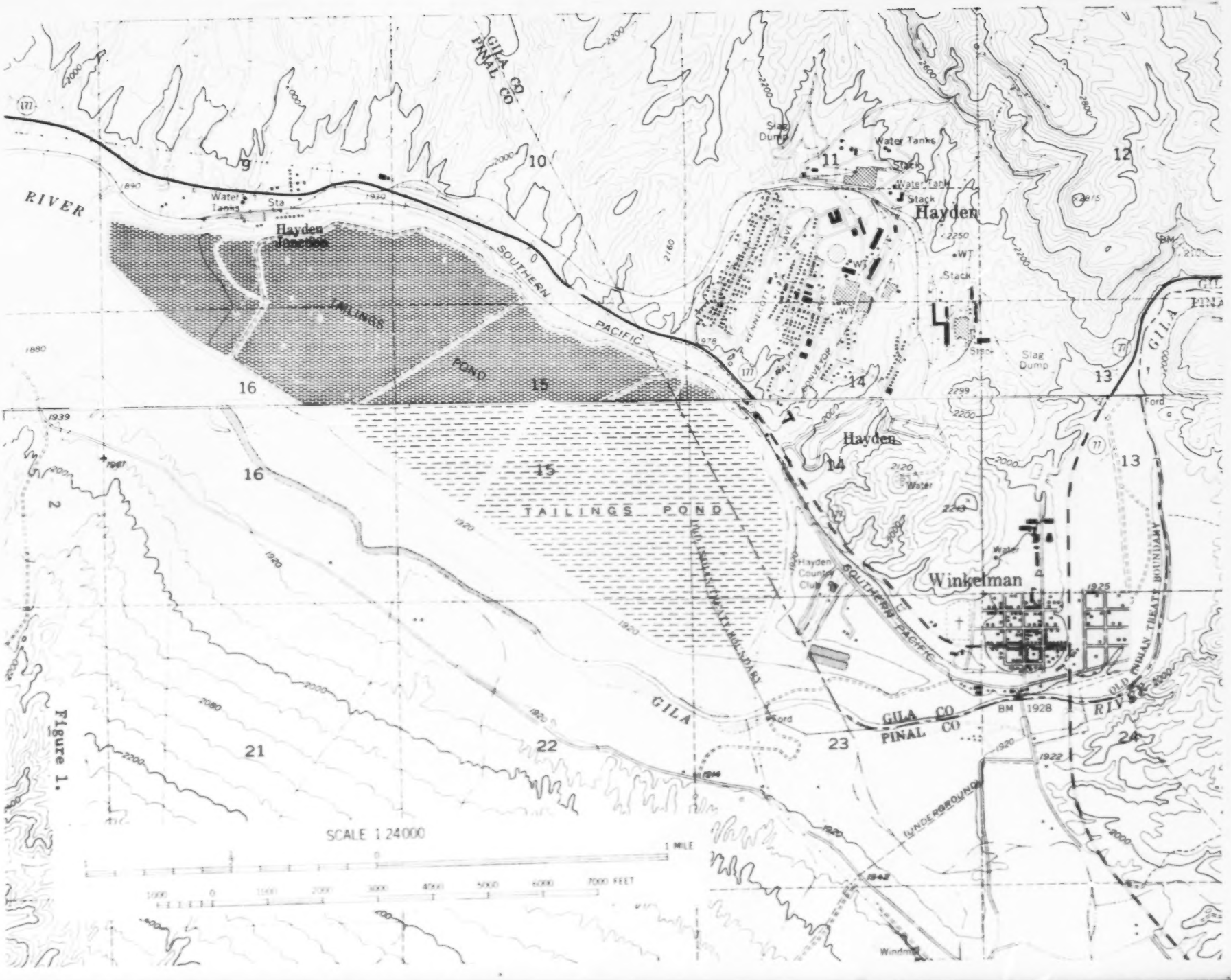
RIVER
Water Tanks
Sta
Hayden Junction
TAILINGS
POND
SOUTHERN PACIFIC
GILA PINAL CO
Slag Dump
Water Tanks
Stack
Hayden
WT
CONVEYOR
Slag Dump
Ford
Hayden
Water
Hayden Country Club
Winkelman
TAILINGS POND
SOUTHERN PACIFIC
GILA
GILA CO
PINAL CO
BM 1928
RIVER
SCALE 1:24000
1 MILE
7000 FEET
9
10
11
12
13
14
15
16
21
22
23
24

Figure 1.

anode casting wheels. The pollution control equipment consists of a settling chamber and cottrell precipitator treating roaster gases, a spray chamber and cottrell precipitator treating reverberatory furnace gases, cyclones, spray chamber, cottrell precipitator, scrubbers, mist precipitators, drying tower and a single contact acid plant for treating converter gases.

Figure 2 shows the overall plant layout. Space for new control equipment could be found on the west side of the roaster and reverberatory furnace main flue leading to the stack and adjacent to the roaster building on the west side.

C. PROCESS DESCRIPTION

The process flow sheet for the ASARCO/Hayden smelter is shown in Figure 3. The tonnages and sulfur balance data shown on the flow sheet are based on actual 1974 data (five full months). The maximum design capacity of the Hayden Plant is for a smelting rate of 2,000 dry tons of concentrates and precipitates per day plus required reverberatory furnace and converter fluxes as feed material. Revert material such as collected dusts, plant cleanup, etc., are routinely recirculated through the system.

Twelve multiple hearth roasters (6-10 usually operating) are used to supply feed for two conventional reverberatory furnaces which provide the charge to five converters. The roaster charge, between 1700 and 2100 TPD, contains 27 to 29% sulfur. Twenty-five percent (25%) of the input sulfur is removed from the feed in the roasters. Eighteen percent (18%) of the input sulfur is removed from the feed in the reverberatory furnaces. This goes either to the atmosphere or the slag. Fifty-seven percent (57%) of the input sulfur is removed from the feed to the converters. There is approximately .2% sulfur by weight in the copper leaving the casting department.

Gases from the reverberatory furnaces pass into four waste heat boilers and are reduced in temperature. The gases leave the waste heat

FIGURE 2

PLANT LAYOUT

(Located in Pocket Inside Back Cover)

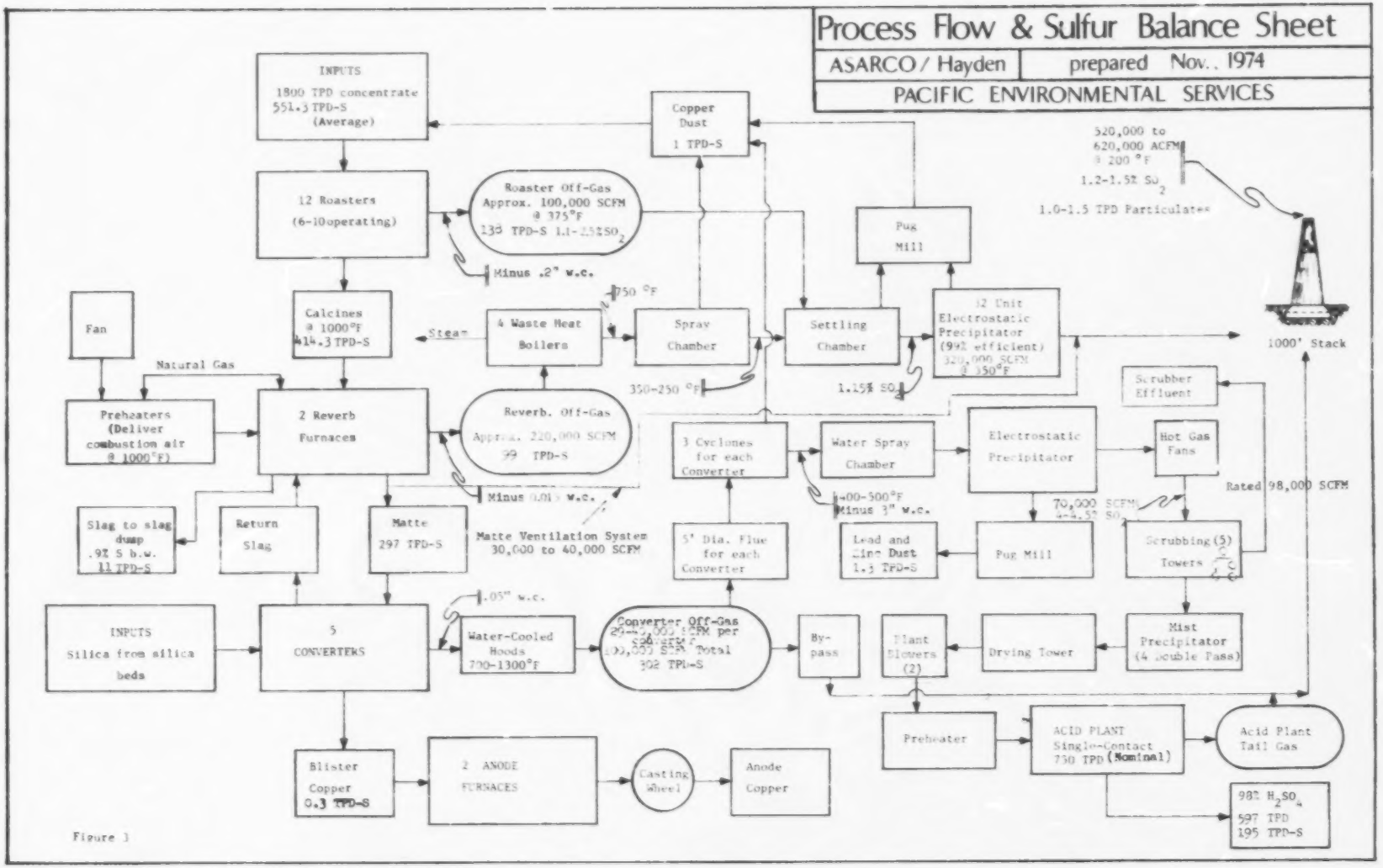
Process Flow & Sulfur Balance Sheet
ASARCO / Hayden
prepared Nov., 1974
PACIFIC ENVIRONMENTAL SERVICES
INPUTS
1800 TPD concentrate
551.3 TPD-S
(Average)
Copper Dust
1 TPD-S
520,000 to 620,000 ACFM @ 200 °F
1.2-1.5% SO2
1.0-1.5 TPD Particulates
12 Roasters
(6-10operating)
Roaster Off-Gas
Approx. 100,000 SCFM @ 375°F
135 TPD-S 1.1-2.5%SO2
Minus .2" w.c.
Pug Mill
Fan
Calcines @ 1000°F
414.3 TPD-S
750 °F
Steam
4 Waste Heat Boilers
Spray Chamber
Settling Chamber
12 Unit Electrostatic Precipitator (99% efficient)
320,000 SCFM @ 350°F
1000' Stack
Natural Gas
350-250 °F
1.15% SO2
Scrubber Effluent
Preheaters (Deliver combustion air @ 1000°F)
2 Reverb Furnaces
Reverb. Off-Gas
Approx. 220,000 SCFM
99 TPD-S
3 Cyclones for each Converter
Water Spray Chamber
Electrostatic Precipitator
Hot Gas Fans
Rated 98,000 SCFM
Minus 0.01 w.c.
Slag to slag dump
.9% S b.w.
11 TPD-S
Return Slag
Matte
297 TPD-S
Matte Ventilation System
30,000 to 40,000 SCFM
5' Dia. Flue for each Converter
400-500°F
Minus 3" w.c.
70,000 SCFM
4-4.5% SO2
Lead and Zinc Dust
1.3 TPD-S
Pug Mill
Scrubbing (5) Towers
.05" w.c.
INPUTS
Silica from silica beds
5
CONVERTERS
Water-Cooled Hoods
700-1300°F
Converter Off-Gas
20-27,000 SCFM per
Converter @
100,000 SCFM Total
302 TPD-S
By-pass
Plant Blowers (2)
Drying Tower
Mist Precipitator (4 Double Pass)
Preheater
ACID PLANT
Single-Contact
730 TPD (Nominal)
Acid Plant Tail Gas
Blister Copper
0.3 TPD-S
2 ANODE FURNACES
Casting Wheel
Anode Copper
98% H2SO4
597 TPD
195 TPD-S

Figure 1

boilers at approximately 750°F. From the waste heat boilers the gases enter a spray chamber where 100 GPM of water is sprayed into the gases further reducing the temperature to 350°F. From the spray chamber the gases are combined with roaster gases passed through a settling chamber and into a cottrell precipitator chamber of 350°F. The total gas flow including roaster gases going to the cottrell is approximately 500,000 ACFM at 350°F. From the precipitator the gases then go to the stack.

Gases from the converters are picked up in water-cooled hoods treated by cyclones, water spray chamber, cottrell precipitator, scrubbing towers mist precipitators, and drying tower before entering the 750 TPD single contact acid plant. Converter blister copper goes to the anode furnaces and is cast into anodes.

Temperatures, volume flow rates and SO_2 concentrations are shown on the process flow sheet, Figure 3.

D. EMITTING EQUIPMENT

a. Roasters

There are 12 roasters, normally 6-10 of them are in operation at any one time. A flapper valve located at the top of each roaster controls the pressure within the roaster to a minus .1 to .2-inch w.c.

Roaster specifications are as follows:

Roasters Nos. 1 through 5 - McDougals, 24' O.D.
steel shell x 23' - 9" high; 6 hearth, 15 HP
motor drive, 2 rpm roaster speed.

Roasters Nos. 6 through 8 - McDougals, 19' O.D.
steel shell x 22' - 9" high, 7 hearth, 10 HP
motor drive, 2 rpm roaster speed.

Roasters Nos. 9 through 11 - Herreshoff, 21' - 7" O.D.
steel shell x 18' - 6" high, 7 hearth, 10 HP
motor drive, 2 rpm roaster speed.

Roaster No. 12 - Bartlett-Snow-Pacific, 25' O.D.
steel shell x 34' - 9" high, 40 HP
motor drive, 2 rpm roaster speed.

Volume flow from the large No. 12 roaster is 20,000 SCFM at 375°F. The smaller roasters (Nos. 1 through 11) produce 15,000 SCFM each. Each roaster has a 5'0" diameter discharge duct with an automatic draft control damper connected to the main roaster flue, Figure 4.

All twelve roasters are natural gas-fired with alternate fuel oil capability. Steel-ventilating hoods on the roaster calcine hoppers, four per roaster each with two pickup points, are connected to a common 12-foot header with six ventilating fans discharging to the roaster flue. Roaster offgases are combined with reverberatory furnace offgases and passed through a settling chamber and electrostatic precipitator before exiting the 1,000-foot stack.

The roaster offloading of the calcines into calcine rail cars is accomplished by opening a slide gate and dropping the material into the car. When loading the calcines a puff of gas is generated when the valve opens. The calcines are at approximately 1,000°F. After loading, the covered car is then moved to the charging floor of the reverberatory furnaces.

All except one of the present 12 multiple hearth roasters are in very poor condition and have a large number of leaks. The company does not feel that the leaking roasters are repairable. Because of the dilution air leakage, the SO_2 concentration in the output gases range from 1.1 to 2.5% and are not suitable to go directly to a conventional acid plant.

b. Reverberatory Furnaces

Natural gas fuel and gas-fired preheated air are introduced into the two reverberatory furnaces where roaster calcines are smelted, forming a liquid matte containing 40% to 45% copper and about 25% sulfur and 25% iron. Slag is skimmed from the top of the furnaces for transfer to the slag dump. Reverberatory exit gases pass through waste heat boilers and are then treated in a water spray chamber for gas cooling and to settle out some of the carryover dust. The reverberatory exit

FIGURE 4

SMELTER GENERAL ARRANGEMENT

(Located in Pocket Inside Back Cover)

gases join the roaster exit gases at the settling chamber. The combined gases are further cleaned of particulate matter in an electrostatic precipitator before exiting the 1,000-foot stack.

The Number 2 reverberatory furnace is approximately 115 feet long by 34 feet wide. The Number 4 reverberatory furnace is approximately 110 feet long by 30 feet wide. Silica-sprung arch roofs with suspended arch uptake and a water-cooled dust curtain are used in both furnaces. Roaster calcines are fed by water-jacketed Wagstaff guns into the reverberatory furnaces. No. 2 furnace has four guns and No. 4 has three. The Wagstaff guns are two-foot diameter water-jacketed cylinders discharging calcine into the furnace through the sidewall. Firing is reduced to 25% when loading the furnace to maintain negative pressure and minimize fugitive emissions. It takes two to three minutes to drop a charge into the furnace and this is done at approximately 15-20 minute intervals. There are four charge points on the No. 2 furnace, and three charge points on the No. 4 furnace. Normal operating pressure is minus .015" w.c., however, it appears that during the loading and at some other times there are positive pressure surges within the furnace (even though the firing rate is reduced during loading).

Preheaters are used to preheat the air for the reverberatory furnace. There is no slag tap hole and four matte tap holes for each furnace. Slag from the reverberatory furnaces containing .9% sulfur, by weight, is sent to the dump.

Fuel gas consumption for the reverberatory furnaces is 190,000 ACFH at 60^{o}F to No. 2 and 160,000 ACFH to No. 4 furnace.

The waste heat boilers for No. 2 Reverb consist of two Erie City boilers, each containing 12,800 square feet of heating surface, 54" diameter steam drum x 41' long, 42" diameter mud drum x 41' long, operated at 400 psig and 750^{o}F steam temperature, and including 18 Copes Vulcan Soot Blowers on each boiler. The waste heat boilers for No. 4 Reverb consist of two Keeler boilers each containing 8,000 square feet of heating

surface, 48" steam drum x 30' long and 48" mud drum x 12' long, operated at 400 psig and 750°F steam temperature, and including 9 "Diamond" steam-operated soot blowers on each boiler.

The I.D. fan for No. 2 Reverb Furnace was manufactured by American Standard, size 2170 DIDW, Series 2480, rated at 200,000 cfm gas at 600°F, 5" static pressure, 391 rpm, 300 HP 4160 volt, V-belt drive. The I.D. fan for No. 4 Reverb Furnace is an American Radiator & Standard Sanitary Corporation, No. 60, Series 106 Industrial Fan, 500 rpm with 200 HP V-belt drive.

c. Converters

There are five converters, one 13 feet in diameter by 30 feet long, three 13 feet in diameter by 33 feet long, and one 13 feet in diameter by 35 feet long. The smaller unit is soon to be replaced by a larger one.

Generally, four ladles are used to load a converter which contains approximately 80 tons per charge. The maximum matte concentration is 55% copper with normal concentration in the 40-42% range. Slag from the converters is returned to the reverberatory furnace. There are two slag return launders on each reverberatory furnace.

Converter air including both blowing air and dilution air varies from 29,000 - 40,000 SCFM. Each converter hood has two dampers, one a bull's-eye, or complete shutoff damper and the other a multi-blade damper for pressure control. There are three fans located in parallel in the converter hood circuit. The fans, manufactured by Westinghouse Electric Corporation, Sturtevant Division, are each rated at 178,000 CFM at 675°F, 2200' elevation and 10" SP. The fan RPM is 604 and requires 465 BHP. The multi-blade dampers are adjusted to maintain negative .05" w.c. at the converter hood. The fans provide plus 1" w.c. at the control before going to the bypass.

Gases from the converter hoods which are water-cooled along the side and have radiation-cooled doors, pass either to the acid plant or are bypassed directly to the stack. Hood temperatures range from 700°F to

1800°F. The gases drop in temperature going through the high-velocity flue from the hoods by approximately 600°F. They reach about 400° - 600°F at the downstream cyclones where a maximum temperature of 650°F can occur. The pressure at the cyclones is -3" w.c.

Each converter has a five-foot diameter flue which transports the gases to three cyclones. The cyclones, in five sets of three, are followed by a water spray chamber, an electrostatic precipitator consisting of four parallel units of three sections each, two gas scrubbing and cooling towers in parallel trains of one open and one packed tower, a mist precipitator consisting of four units of two sections each, a drying tower and the single contact acid plant. A more detailed description of the gas cleaning equipment can be found in the next section. Normally, 4-4.5% SO_2 is contained in the gases going to the acid plant.

d. Other Emitting Equipment

Material handling in the unloading and sampling area generates some particulate matter. Truck deliveries of tailings and rail deliveries of limerock are dumped into receiving hoppers. The material is damp, about 10% moisture content, and does not cause a major fugitive dust problem. Crushing and screening operations occur, but are not considered major sources of particulates.

The two anode furnaces generate small quantities of SO_2 and particulates.

Calcine cars handling reverberatory furnace feed generated by the roasters, during loading or unloading, can generate particulate. Four to five cars are used.

Six 200-cubic feet cast steel ladles are used for handling molten slag and matte from the reverberatory furnaces. Five 150-cubic feet cast steel ladles are used for handling blister copper. Visible fugitive emissions are encountered during ladle transfer.

E. EXISTING CONTROL EQUIPMENT

a) Roasters and Reverberatory Furnaces Control Equipment

The layout of the control equipment treating roaster and reverberatory furnace offgases is shown in Figure 4. Reverberatory furnace offgases pass through waste heat boilers and a spray chamber before joining the roaster offgases in a settling chamber. The No. 2 Reverberatory Furnace is equipped with two Erie City waste heat boilers and the No. 4 Reverberatory Furnace is equipped with two Keeler waste heat boilers. The reverberatory furnace gases leave the waste heat boilers at about 750°F and are then cooled in a spray chamber to about 350°F. The spray chamber is approximately 18 feet wide by 21 feet high and 192 feet long. The spray chamber construction is brick with an automatic water spray system and temperature controller.

The cooled reverberatory furnace gases join the roaster gases in the settling chamber. The settling chamber is 38 feet wide by 43 feet high and 223 feet long with 13-inch brick walls, steel arch beam supports, arches of 1/4-inch steel plate and refractory cover. Following the settling chamber is a plate and wire type cottrell precipitator. The roaster and reverberatory furnace precipitator is eight chambers wide with four sections per chamber. The precipitator is reported to be operating at 99 + % collection effeciency (Ref. 6). From the precipitator the gases pass out the stack with no SO_2 control.

b) Converter Control Equipment

The general layout of the control equipment treating converter offgases is shown in Figure 4.

Gases from the converter hoods are cleaned in cyclones and cottrell precipitators then pass either to a single contact acid plant or are bypassed directly to the main stack. Each of the five converters is serviced by three cyclones before secondary dust collection in cottrell precipitators. The cottrells consist of four parallel chambers with

three stages in each chamber. The total collecting plate area is 126,800 square feet and the electrical field volume is 52,048 cubic feet. The operating efficiency is reported to be 97%. Converter gases are then bypassed to the new 1,000-foot stack or are further cooled and cleaned of particulates in two parallel trains of scrubbing towers. The first scrubber in each train is an open tower and the second scrubber is a packed tower. Following the scrubbers is a mist precipitator consisting of four units with two sections in each. The gases then pass through a drying tower before entering the acid plant. The sulfuric acid plant is a single contact type designed by Chemiebau and installed by Rust Engineering, with a design rating of 750 TPD at 98,000 SCFM (dry basis) of 4.12% SO_2 inlet gas treated at 90°F (Ref.5). The gas volume leaving the converters ranges from 25,000 to 110,000 SCFM, depending on the number of converters operating. Normally, 4% to 4.6% SO_2 is contained in the gases entering the acid plant. Typically, three converters are blowing most of the time. Assuming an average tuyere air flow of 20,000 SCFM plus 50% inspirated ambient air at the hood, the total volume to the acid plant is approximately 30,000 SCFM for three converters. The acid plant was designed to handle 98,000 SCFM. At an entrance SO_2 concentration of 4.12%, ASARCO claims that acid plant emissions of 2,000 ppm are attained. A preheater is used when the SO_2 in the gas stream reaches 3%. Operation of the plant can continue if the gas stream concentration goes to zero for a period of 15 minutes without turning on the preheater. Beyond this point a small amount of gas is recirculated, particularly when all converters are out. There are two acid plant blowers in parallel that are operating continuously.

The acid plant was designed in 1968 and started up in 1971. The plant produced 182,989 tons of acid in 1972 and 117,386 tons of acid in the ten-month period for 1973. The acid plant has experienced operating problems and was down the entire month of October and half of November in 1973 for repair. The plant is capable of making clear commercial grade sulfuric acid at either 98% or 94% concentration. ASARCO is presently shipping acid to Southern California due to the lack of local markets.

Presently, the acid plant is not capturing the total amount of sulfur leaving the converters. Based upon the material balance, 296 TPD of sulfur are being emitted from the converters. To collect this amount of sulfur a 907 TPD acid plant would be required. Therefore, an additional acid plant capacity of 157 TPD appears necessary. However, ASARCO is currently attempting to increase the capture capacity of the existing acid plant by rework rather than adding additional equipment and have scheduled total converter-gas sulfur capture by the end of 1975. ASARCO has indicated that the acid plant design capacity will be increased to 1008 TPD at 5.5% SO_2 inlet gas concentration and 98,000 SCFM (Ref. 5).

ASARCO has designed a moving hood over the ladles for the matte tapping which comes down on a hinge and completely covers the ladle. There are several small square openings in the hood to allow the operator to determine the level in the ladle. This is an effective approach for minimizing fugitive emissions from ladles containing molten material.

F. GAS SYSTEM DUCTWORK

a) Roaster and Reverberatory Furnace Ductwork

The gas system ductwork layout for the roasters and reverberatory furnaces is shown in Figure 4. Each roaster has a five-foot diameter discharge duct with draft control damper. Offgases collected from the twelve roasters travel through the roaster flue to the dust settling chamber described in Section E. A 200 HP induced draft fan provides the draft for No. 8 through No. 12 roasters. Draft for the remaining roasters is provided by natural stack draft. The roaster flue dimensions are 13 feet wide by 15 feet high by 245 feet long. The roaster flue has 13-inch brick walls, steel arch beam supports, arches of 1/4-inch steel plate and refractory cover.

After passing through waste heat boilers and a spray chamber, described in the previous section, reverberatory furnace gases join the roaster gases in a dust-settling chamber and are treated in a plate and

wire cottrell precipitator. From the precipitator the gases are carried by brick flue to the new 1,000-foot main stack. The roaster and reverberatory furnace gas flow typically is 320,000 SCFM at 240°F. The brick flue dimensions are 19 feet wide by 20 feet high. The length of the flue is about 500 feet. Before completion of the 1,000-foot stack in 1974, the roaster and reverberatory furnace gases were discharged to a 300 foot stack located north of the new stack.

Elevations of ductwork at centerline follows:

No. 4 Reverberatory Boiler Offtake Flue	2,165'-3"
No. 2 Reverberatory Boiler Offtake Flue	2,188'-11"
Reverberatory Spray Chamber	2,152'-7"
Cottrell Settling Chamber	2,152'-7"
Main Flue Inlet to 1,000-Ft. Stack	2,207'-0"
Roaster Flue	2,202'-6"

b) Converter Ductwork

The converter flue system is shown in Figure 4. Converter gases are treated for removal of particulates and SO_2 in the control equipment described in Section E. Converter gases are, after particulate removal, treated in an acid plant or bypassed directly to the main stack. The new flue system is constructed of Cor-ten A steel and is 8' - 9" in diameter and has a Precrete lining the entire length. The flue is designed to handle up to 224,000 SCFM at 200°F with a gas velocity of about 5,000 feet per minute. Typically, the gas volumetric flow will be about 100,000 SCFM. Elevations of the converter high velocity flues are 2174'-0" for three converters and 2166'-0" for two converters. Elevation of the converter gas flue to the 1000-foot stack is 2241'.

G. SULFUR BALANCE AND GAS COMPOSITION AT SYSTEM EXIT

A typical sulfur balance, based on 1974 data, (5 full months),

Reference 1, at 1,800 TPD smelting rate is presented in Table I. Of the 551 TPD sulfur input to the smelter approximately 207 TPD are removed in the acid plant or report in the slag and solid waste. Approximately 344 TPD of sulfur are emitted from the main stack.

The 1973 average sulfur balance is presented in Table II. The lower value of TPD of sulfur captured reflects the operating problems experienced with the acid plant which resulted in a large amount of down time (the entire month of October and half of November). Table III represents similar data from Reference 2.

Roaster and reverberatory furnace gases enter the main stack at about 340°F with a typical gas volume of 320,000 SCFM. The gas flow is dependent on the number of roasters and reverberatory furnaces operating. Particulate emissions from the roasters and reverberatory furnaces at the stack are approximately 1.0 to 1.5 TPD. The SO_2 concentration of the roaster and reverberatory furnace gases ranges from 1.1 to 2.5%. Converter gases after dust removal and treatment in the acid plant, are sent to the stack at approximately 200°F with a gas volume of 100,000 SCFM. The SO_2 concentration in the acid plant tail gas is about 2,000 ppm and the particulate concentration is essentially nil. Variations up to 4,100 ppm SO_2 have been measured. At the stack exit the gas flow is typically 420,000 SCFM at 200°F and 1.2 to 1.5% SO_2. Table IV, Reference 2 summarizes acid plant tail gas sampling data.

Additional emission data from Reference 3 follows.

Point: Downstream from R&R Cottrell following spray chambers - Rectangular duct 19.6' x 18.8' inside

Roasters Operating	H_2O% b.v.	SO_2% b.v.
2	5.9	.44
4 - 1 hour 2 - 3 hours 7 - 1/2 hour	6.9	.48
4 - 6 (Aug. 5)	6.8	.41
Maximum	7.9	

TABLE I.

ASARCO/HAYDEN

SULFUR BALANCE SUMMARY*

Sulfur Input	Roaster		Reverb		Converter		Slag and Solid Waste	Fugitive Emissions	Present Sulfur Captured	Stack Emissions
TPD-S	% SO_2	TPD-S	% SO_2	TPD-S	% SO_2	TPD-S	TPD-S	TPD-S	TPD-S	TPD-S
551.3	1.1 to 2.5	138	0.7	99	4.7	302	12.3	-	207.3	344

*Based on 1974 data (5 full months) @ 1800 TPD submitted to the State of Arizona
Fugitive emissions not reported.

TABLE II.

ASARCO/HAYDEN

SULFUR BALANCE SUMMARY*

Sulfur Input	Roaster		Reverb		Converter		Slag and Solid Waste	Fugitive Emissions	Present Sulfur Captured	Stack Emissions
TPD-S	% SO_2	TPD-S	% SO_2	TPD-S	% SO_2	TPD-S	TPD-S	TPD-S	TPD-S	TPD-S
588	1.1 to 2.5	142	0.7	98	4.7	309	18	21	161	427

*Based on 1973 averages

TABLE III.

SULFUR BALANCE

	%	TPD
Converter	28.25	156
Reverberatory Furnace	16.[illegible]	91.3
Roasters	24.1	133
Fugitive	3.6	19.8
Slag Dust Blister	3	16.5
Converted to Acid	24.4	134.4
	99.95	551

Reference 2.

TABLE IV.

STACK SAMPLING TESTS

Type:	SO_3 and Acid Mist
Location:	Acid Plant Tail Gas
Method:	Isokinetically collected with filter and impingers with isopropyl alcohol. Titrated with weak basic solution.
Date:	11/8/71, 11/22/71, 11/30/71, 12/2/71, 12/3/71
Results:	SO_3 Content in Tail Gases - 0.0005-0.0019 grams/SCF H_2SO_4 Content in Tail Gases - 0.0004-0.0012 grams/SCF Total SO_3 - 0.00086-0.0029 grams/SCF
Type:	SO_2
Location:	Acid Plant Tail Gases
Method:	Reich Iodine Method
Date:	11/8/71, 11/22/71, 11/30/71, 12/2/71, 12/3/71
Results:	SO_2 Content in Tail Gases - 0.0965-0.325%
Type:	SO_2
Location:	Acid Plant Tail Gases
Method:	Reich Iodine Method
Date:	4/18-20/72
Results:	SO_2 Content in Tail Gases - 0.18-0.37%
Type:	SO_2
Location:	Acid Plant Tail Gases
Method:	Reich Iodine Method
Date:	8/3-4/72
Results:	SO_2 Content in Tail Gases - 0.25-0.41%

Reference 2.

Point: #12 Roaster - 700 TPD Process Weight - Volume flow rate 22,945 ACFM @ 480°F

	H_2O% b.v.	SO_2% b.v.
	16.45	3.77
	9.83	3.5
Range	9.83 - 17.00	1.24 - 4.42

.15 - .18" H_2O minimum draft

Point: #2 Reverberatory Furnace flue downstream of waste heat boiler - 7' high by 3'3" wide flue - Volume flow rate 128,800 ACFM @ 465°F
SO_2 range .51% to 1.67%.

Point: #2 Reverberatory Offgas

Firing Rate, CFH	Volume Flow Rate ACFM
121,000	123,500 @ 510°F
146,800	138,000 @ 570°F
165,400	173,000 @ 600°F

Point: High velocity flue to acid plant

Converter Operation	SO_3 PPM
5 Blowing	850-1008
1 Finish, 1 slag	619
1 Finish	1395
2 Slag, 1 finish	341
2 Slag	87

Point: #1 Converter Flue
Volume flow rate 25,900 - 35,900 SCFM
(32°F and S.L.)

#2 Converter Flue
Volume flow rate 40,400 - 43,000 SCFM
800 - 1000°F

-.02" to -.05" H_2O Hood Draft

#4 Converter Flue
Volume flow rate 135,000 ACFM @ 835°F

Point: One Converter on Slag Blow over One-Hour Period
Volume Flow Rate 115,200 ACFM @ 780°F.
Velocity - 5867 FPM - 5' Dia. Flue

SO_2, %	SO_2, %	SO_2, %
2.25	3.47	3.53
4.92	4.15	3.14
2.52	3.81	3.01
3.58	3.71	2.83
3.94	3.56	2.83
4.17	3.16	3.36
3.84	2.36	4.15
3.31	2.09	3.3 Avg.
3.47	2.36	
3.94	2.38	
3.64	2.78	
3.55	3.45	

Analysis of Dust from R&R Cottrell

Cu - 14.8% b.w.

Z_n - 2.4% b.w.

P_b - 2.2% b.w.

H. GAS CHARACTERISTIC VARIATION

It can be expected that SO_2 concentration in the off-gas from the reverberatory furnaces will vary significantly with time. This results from the variation in time required for decomposition or reaction of the various sulfide ores charged to the furnaces. This variation in SO_2 content has been known to vary as much as 10 to 1 within a given charging time cycle. Figure 5 shows SO_2 % b.v. versus time in minutes indicating variation of over 3.0% down to .25% within a 15-minute period at the Hayden smelter. The furnace is charged at 15-minute intervals.

SO_2 concentration in the converter off-gas will also vary considerably for an entirely different reason. The operation of a converter includes several, usually three, slag blows and one copper blow. Between these blows the converter may be rolled out for slag pouring or material charging. When the converter is not blowing the hood above the converter is closed off by dampers so that the gases do not pass through the collection system to the acid plant. The attempt is always made to maintain at least one converter blowing gases into the system at any given time. On average, 2.36 converters are blowing continuously at Hayden. Usually, a converter will be provided with 20,000 SCFM to the tuyeres. An additional 50% to 100% of dilution air is estimated to be added to this gas flow resulting in a total gas flow from each converter in the range of 30,000 to 40,000 SCFM. During slag blows the SO_2 content will be in the range of 4.0 to 4.6%. During copper blows the SO_2 content will be in the range of 6 to 8%.

Because of the normal fluctuation in converter feed and operation, the SO_2 concentration can vary over a relatively wide range. In addition, the gas volume flow from the converter line to the control system acid plant can usually vary over a wide range from maximum to zero. Operation of the control system must be conducted in a manner to compensate for these fluctuations. Significant acid plant downtime occurred in 1973 due to operating problems. ASARCO is currently reworking the acid plant to increase its capture capacity.

ASARCO HAYDEN VARIATION IN SO_2 CONTENT OF REVERB GAS STREAM

Average SO_2 = 0.89% Gross Thermal Input = 50 BTU/SCF of Gas

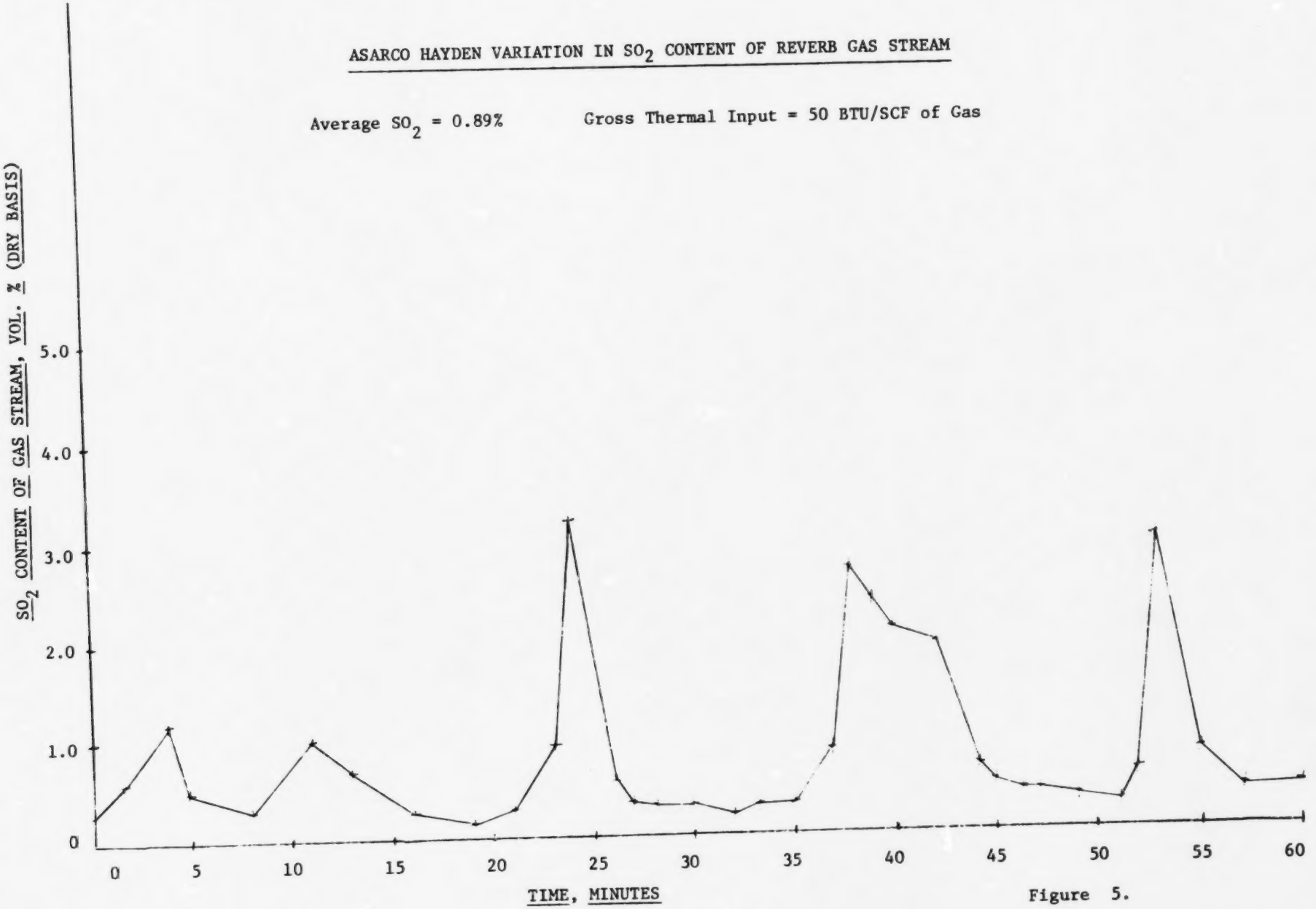

Figure 5.

I. STACK DESCRIPTION

A plan view and sectional elevation view of the 1,000-foot main stack is shown in Figure 6. The main stack was completed in March of 1974 and discharges all equipment offgases from the roasters, reverberatory furnaces, converters, and the acid plant. The stack is a double shell design constructed of steel reenforced concrete. The inside diameter of the stack at the top is seventeen feet and at the base is 45'2".

J. SOLID WASTE HANDLING

Slag from the reverberatory furnace is taken by open-top rail car to the slag dump. Roaster and reverberatory furnace dust collected in the settling chamber and cottrell precipitator is taken by screw conveyor and dumped into a pug mill where it is processed and returned to the ore bed for recycle through the smelter. Converter slag is returned to reverberatory furnaces. Dust from the precipitator in the converter gas cleaning system is taken by screw conveyor and processed in a pug mill prior to shipment to the ASARCO/El Paso smelter.

K. FOOTING REQUIREMENTS

If construction is to be carried out in some areas, footing tests would be required, particularly if a slag base is evident. The area to the west of the roasters could be used for control equipment installation.

No local codes apply. The Seismic zone is 2 and the wind load and snow load used for design are 20 pounds per square foot.

L. EXISTING AND POTENTIALLY AVAILABLE UTILITIES

The smelter purchases part of its electricity. At present the inplant utility is fully utilized. Salt River Power District substations and transmission lines feeding the plant have capability of supplying approximately an additional 5 megawatts. Water is obtained from wells.

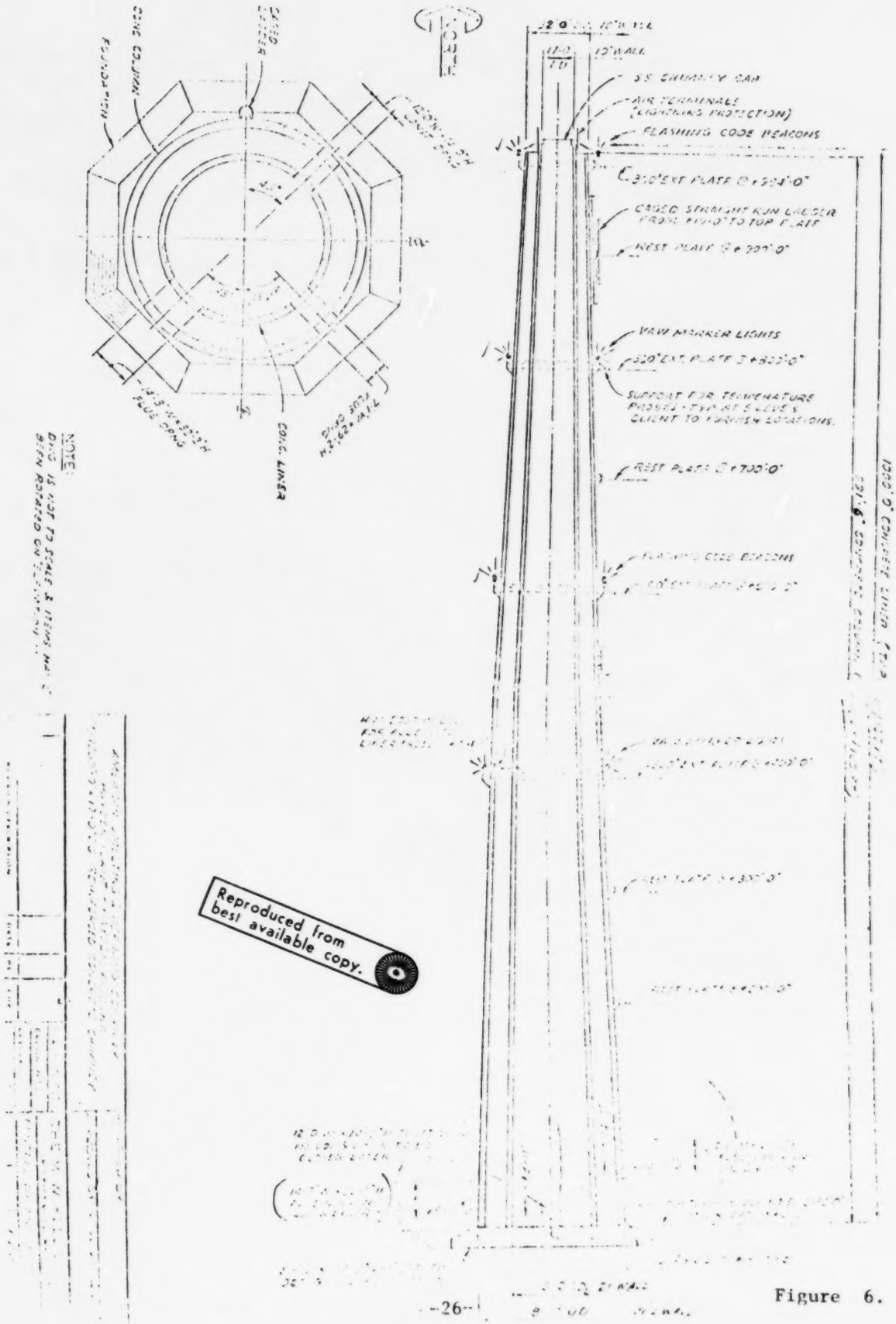
SS CHIMNEY CAP
AIR TERMINALS (LIGHTNING PROTECTION)
FLASHING CODE BEACONS
CASED STRAIGHT RUN LADDER FROM 100'-0" TO TOP PLATE
REST PLATE @ + 200'-0"
VAN MARKER LIGHTS
SUPPORT FOR TEMPERATURE PROBES - EYE BOLTS CLIENT TO FURNISH LOCATIONS.
REST PLATE @ + 700'-0"
CONC. LINER
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Figure 6.

There is no additional gas available for fuel. If additional fuel is required, oil must be used.

Steam generated by the smelter is used for electrical power generation and to power steam blowers for the converters.

M. POTENTIAL NEW CONTROL EQUIPMENT INSTALLATION PROBLEMS

Available area for installation of control equipment is somewhat limited. The most likely space is the slag dump area on the east side of the plant.

REFERENCES

1. ASARCO memo - M. J. Winkel to F. M. Covington (EPA) 8/30/74.

2. ASARCO memo - L. G. Cahill to K. D. Loughridge, 5/19/75.

3. Discussion with E. Godsey, ASARCO Central Engineering, Salt Lake City, Utah.

4. The Evaluation of the Controllability of SO_2 Emissions from Copper Smelters in the State of Arizona. June 1975, Pacific Environmental Services, Inc.

5. ASARCO Comments on Draft Report - K. W. Nelson to I. J. Weisenberg (PES), 9/22/75.

6. Personal Communication with L. G. Cahill, 10/15/75.